WHEN THE EARTH TREMBLES IN THE AMERICAS: THE EXPERIENCE OF HAITI AND CHILE 2010

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A. INTRODUCTION

On Tuesday January 12th, 2010, 16.53 local time (21.53 GMT), a 7.0 earthquake struck Haiti (fig 1A). The epicenter was located in Léogâne, 25 km west of the densely populated Port-au-Prince metropolitan area (3,000,000 inhabitants). More than 220,000 people died and more than 310,000 were wounded. Less than two months later, an 8.8 earthquake affected the Maule region in Chile, on February 27, 2010 (fig 2).

The Renal Disaster Relief Task Force (RDRTF) of the International Society of Nephrology (ISN) offers nephrological support in mass disasters, essentially massive earthquakes where a large number of patients develop Acute Kidney Injury (AKI) due to rhabdomyolysis and crush syndrome [1-4]. In some cases, as in Marmara, Turkey [5;6] (477 dialyzed); Bam, Iran [7] (106 dialyzed); and Kashmir/Pakistan [8;9] (55 dialyzed) RDRTF provided clinical and dialysis support (Table 1); in other disasters, only an assessment team was dispatched or advice was given [8;10;11]. All interventions are integrated into the medical activities of Médecins Sans Frontières (MSF – Doctors without Borders).

In this publication, we describe the characteristics, problems, successes and lessons of the intervention of the RDRTF/ISN in Haiti, together with the nephrological implications of the Chilean earthquake.

B. THE HAITI EARTHQUAKE

a. Number of expected AKI

AKI in need of dialysis is expected after any major seism in a rapidly growing and densely populated urban area, with constructions which are not necessarily earthquake-resistant [12]. From previous interventions it is known that specific circumstances influence the number of AKI occurring with each earthquake [9]. In case of the Haitian disaster, many unknown factors made an appropriate prediction impossible.

On the 13th of January, 10 hours after the disaster, an assessment team of RDRTF/ISN was dispatched from Europe [13], consisting of one nephrologist, two renal nurses and one dialysis technician. The first team members arrived in Port-au-Prince, in the morning of Friday 15th of January, to be followed later on by several additional teams, all of which being part of larger MSF groups.

b. Local medical conditions

Many major buildings, including hospitals, were severely damaged (Fig 1B) [14]. Hospital capacity in Port-au-Prince was overwhelmed by the massive number of patients in need of treatment. The number of amputees amounted to at least 2,000 [15]. There were no functional facilities for basic laboratory measurements (e.g. potassium, creatinine), blood cultures, diagnostic imaging or intensive care in the first weeks.

Before the earthquake, there were approximately100 chronic hemodialysis patients, treated in at least 4 units across Haiti. One unit was destroyed by the earthquake. No patients were on peritoneal dialysis.

The RDRTF/ISN assessment team found a partly intact dialysis unit in the University Hospital (HUEH – Hôpital Universitaire de l'Etat d'Haïti) (Fig 3, Fig 4A-D). Several other sections of the hospital had

been destroyed (Fig 3). The unit was equipped with four 10-year-old dialysis machines (Fig 4B). A water softening and reverse osmosis system (Fig 4C-D), with a 200 gallon storage tank (Fig 4E), distributed water into a loop with nine connections. The general water delivery was cut off, as was the piping to connect the softeners (Fig 4C), but all RDRTF/ISN teams included dialysis technicians, who were able to repair non-functional dialysis machines and make water treatment systems operational (Fig 4F).

While all other medical MSF teams worked in several other hospitals spread over the city, the nephrological team concentrated on HUEH because of the preserved hemodialysis unit.

c. Characteristics of the dialyzed population

Overwhelming conditions made proper case registration and obtaining certainty about outcomes difficult.

In at least 30 patients with crush-related AKI in Port-au-Prince, dialysis could be avoided by appropriate screening and fluid prevention. Another 27 patients with AKI needed dialysis, and to them a total of 117 hemodialysis treatments were provided. Nineteen of these patients had AKI due to crush injury, whereas eight were non-crush associated. Of the latter, the majority was suspected to have had previous undiagnosed CKD, mainly due to diabetes, hypertension or HIV. Acute on chronic renal failure was in most cases precipitated by infection or stress-related hypertensive crises. The age of the patients with crush-AKI (mean±SD) was 30±11 years (range 16-58), while that of patients with acute on chronic kidney disease was 37±16 (range 15-55). The creatinine level before the first dialysis was 13.2±4.1 mg/dL (range 8.1-20.0), blood urea nitrogen 138±17 mg/dL (range 105-140), potassium 7.8±0.8 meq/L (range 6.1-8.8) and sodium 125.0±3.8 (range 119.0-130.0).

Five of the 19 patients with crush were lost to follow-up overnight after their first dialysis; four of them very likely died. Another patient suffered from obstructive renal failure, was dialyzed once, and then probably was operated, so that it is conceivable that she recovered. Four patients were dialyzed and subsequently transferred to the USA hospital ship, USNS Comfort, for advanced care. One patient with delayed recognition of crush injury and AKI died during helicopter evacuation to Santo Domingo for critical care. All remaining patients survived and recovered renal function, confirming previous observations in larger populations [16]. Four patients required above knee amputations. One of the 8 non-crush AKI patients died from respiratory failure and sepsis, another recovered kidney function after rehydration, while 6 remained on chronic dialysis when our intervention ended.

In addition, RDRTF/ISN provided therapy to approximately 30 patients with chronic renal failure requiring dialysis at HUEH and assisted the local dialysis nurses and technicians with education and support. The team also worked with the local nephrologists and vascular surgeons to optimize vascular access. No active search for CKD was undertaken, to avoid overloading the dialysis unit with a number of patients largely in excess of those prior to the disaster. Some chronic dialysis patients conceivably died in the earthquake or the days following or went abroad. A diaspora of chronic dialysis patients in the aftermath of disasters has been described at other events as well [17-19].

We are aware of a total of 32 Haitian crush patients with AKI who were dialyzed in DR. Another 11 were managed conservatively. All but one survived and those surviving recovered kidney function.

The few additional AKI patients who were dialyzed on the USNS Comfort all recovered, as far as we know, kidney function.

Assuming that all patients who were lost to follow-up died, mortality of dialyzed crush victims in Haiti was 32%, which is higher than in most other disasters [7;8;11]. However, taking into account the patients in DR as well, mortality was 19%, conform to the other disasters. It is likely that mostly patients in relatively better condition could move to DR. A similar improved survival with treatment performed at increased distance from the epicenter was also seen in other disasters [2;20].

d. Difficulties during intervention

1) Logistics

The harbor of Port-au-Prince was largely destroyed and the airport was too small to process the intense shifts of people and material. Both RDRTF volunteers and material entered the island via the Dominican Republic (DR), the volunteers initially travelled by road to Port-au-Prince, necessitating an average travel time of four days back and forth for most volunteers; this took up to 66% of a total mission. This situation necessitated transition between teams to be anticipated well in advance (Fig 5).

Travel time for material was even longer. Three dialysis machines of the RDRTF/ISN that were dispatched on January 15th only became available on the 20th, because the aircraft carrying this material could land in Port-au-Prince airport only then [21]. Subsequently, material was imported from nearby Martinique, but this too was complicated by customs issues and eventually increased the duration of the mission by two weeks (Fig 5). The easiest way to ship light material, was in the hand luggage of new incoming rescuers.

Transport within Port-au-Prince was also heavily disrupted, due to severe infrastructure damage, roads being blocked by movements of people and material, and initially by corpses and wounded lying in the streets (Fig 6A and B). This hampered missions for screening of kidney function and communication with other hospitals treating potential AKI patients throughout the city, as well as centralization in the hospitals which were overcrowded and lacked sufficient material [22] (Fig 6D-F). Usually open spaces serve as casualty collection points [23], but in Haiti almost all such areas were occupied by homeless people.

2) Distribution of AKI patients over two countries

Many wounded victims sought primary care in the border area in DR around Jimani and some were moved to Barahona, which is one hour away from the frontier. From the 16th of January onwards, Haitian AKI patients were also treated in DR (Fig 1A); the first dialysis occurred on January 18th. The nephrological comunity in DR could cope with this influx, benefiting of material and advisory support by the Sociedad Latino-Americana de Nefrologia e Hipertension (SLANH), the American Society of Nephrology (ASN) and MSF. Dialysis was concentrated in Santo Domingo, Santiago, San Juan, Barahona and San Pedro (Fig 1A).

Thus, of the nephrological communities involved with external support, the Disaster Relief Task Force (DRTF) of ASN and the SLANH mainly concentrated on DR, and RDRTF/ISN on Haiti.

3) Chaotic and unsafe situation

The usual approach by the RDRTF/ISN is to install a dialysis bridgehead, outside the damaged zone [5;8;24]. During this disaster, RDRTF/ISN activities had to be organized in the damaged area, allowing more contact with several surrounding hospitals with potential AKI cases as an advantage

compared to our usual approach. Disadvantages on the other hand were less flexibility in dialysis timeframes, and major safety concerns.

Chaos is present after almost every disaster, even if the event is predictable [17;25]. The situation in Port-au-Prince remained chaotic and unsafe especially at the beginning of the mission. As MSF had been working in the poorer areas of Port-au-Prince before the disaster, where they were running a health center, a trauma unit and a maternity hospital, their familiarity with these challenges was a major advantage.

The contribution of local nephrological nursing and medical staff could initially not cover the enormous needs. During the first days, the dialysis unit at HUEH was found unmanned; approximately 80% of hospital staff was homeless and living on the streets. In addition, in some facilities and for various reasons, there was no nursing or medical surveillance possible overnight.

4) Shortage of laboratory facilities

For three to four weeks, there were no medical laboratory facilities in Port-au-Prince to measure essential biochemical parameters, reducing the capacity to detect AKI and its life-threatening electrolyte disturbances. In response, MSF supplied a new point-of-care device (i-STAT, Abott, USA) with testing materials and the RDRTF became the first rescue team to use such device in the disaster zone. This was a major advantage since it permitted patient stratification for conservative management or dialysis, recognizing the scarcity of dialysis possibilities and of intravenous fluids for rehydration. The device was in high demand by other hospitals and NGOs, but can only operate within a limited temperature range. This was overcome quite soon by maintenance and transport in a cooled insulated container, provided by MSF, permitting use in ambient temperatures up to 35°C. From then on, the i-STAT became a very useful device, which permitted the RDRTF to assist other teams with management of electrolyte imbalances and monitoring of critically ill patients, e.g. diabetics with ketoacidosis.

Also in the border area of DR, screening and triage were hampered by lack of laboratory reagents, which became available only after 5 days. At a later stage, ASN donated two i-STAT machines to Haiti and another two to DR.

5) Communication problems

Initially, no contact from outside with Haiti was possible; subsequently only, limited exchanges via satellite telephone, SMS and email were possible, which sometimes necessitated taking important logistic decisions in spite of limited background information.

Communication was also limited within the disaster area. Although members of the RDRTF regularly visited several local and field hospitals for AKI screening and creating awareness of dialysis possibilities, this information was often lost, due to rotations in hospital teams and their leadership. In addition it was impossible to reach all hospitals and rescue teams (in total at least 30 regular and field hospitals [26]). Cases of AKI were, therefore, missed [22].

Although central coordinating bodies like Office for the Coordination of Humanitarian Affairs (OCHA) daily met with groups active in the field to disseminate information about practical possibilities, not all stakeholders were present at all meetings, and, information did not always seep down to the field workers. Probably regulatory bodies were also overwhelmed by the disproportionate

number of victims as well as by heavy losses among their own ranks, if, like WHO or UN, they were present in Haiti already before the disaster.

e. Lessons learned

1) Deployment of personnel

The usual approach by RDRTF is to deploy teams of doctors, nurses and dialysis technicians. The teams in Haiti contained proportionately more physicians than previous missions (Fig 5 and Table 2), because of initial emphasis on screening and prevention, and in a later phase on teaching, e.g. of placement of tunneled catheters.

The distribution of nationalities is illustrated in Table 2. Three of the volunteers of French nationality were residents of nearby French overseas Caribbean Departments (Martinique and Guadeloupe). Teams always contained volunteers with previous experience of RDRTF interventions and/or knowledge of French.

Due to the long travel times, duration of each individual mission was longer than in most other interventions and lasted from 8 to 17 days. The total number of intervention days was 316 for 25 participants (average: 12.6 days).

2) Factors influencing patient flow

Comparing this disaster with its 222,517 deaths and 51 AKI patients with crush to other disasters, the prevalence of AKI was low (Table 3).

Several factors may have influenced this, such as the daytime occurrence when people are up and about, favoring head and chest trauma and decreasing compression trauma to muscles; the presence of many buildings which were not sturdy enough to cause severe muscle trauma; difficulties encountered with early rescue; extrication of most victims by neighbors or family members, resulting in a selection of less heavily wounded and a lack of immediate medical help for the occasional severely affected victim. Specific to this disaster, mortality due to suffocation by collapse of low-quality buildings, chaos hampering screening, lack of safety minimizing the possibilities for appropriate treatment 24 hours per day, communication and logistic problems, and the availability of effective dialysis only several days after the disaster, all added to the high mortality. Finally, preventive fluid resuscitation very likely kept several patients off dialysis.

The number of 51 dialyzed crush patients remains remarkable in view of the extreme conditions. It cost major efforts to start and maintain dialysis, so that each saved life should be considered as an accomplishment. Nevertheless, with better conditions the number of dialyzed AKI should have been higher.

3) Intervention in future disasters

This type of technological intervention is a challenge in an area with minimal infrastructure, or with an excessive number of victims. In Haiti, both prevailed.

The RDRTF/ISN had to install what was essentially a *de novo* dialysis unit. Although a water treatment system and dialysis machines were present, both needed upgrading and repair, while nine additional machines were introduced to increase capacity. Of note, all our teams included a dialysis

technician, and the mission would not have succeeded in providing a functioning unit without their assistance. Hence, worldwide advance volunteer recruitment must not be restricted to doctors and nurses, but should include dialysis technicians as well. What was accomplished is only one step away from creating an entirely new dialysis unit; based on the Haiti experience, this seems feasible. However, the long-term sustainability of such an intervention still needs to be proven.

Single pass hemodialysis with sufficient dialysate flows remains the most desirable option in crush-AKI because of 1) sufficient solute removal, especially potassium; 2) limited cargo volume at transport; 3) minimal bleeding risk. Alternative options have to the best of our knowledge not been demonstrated to perform as well on one or more of the three points above.

RDRTF/ISN also focused on patient selection and fluid prevention. This aspect should be further optimized based on our current experience; in future, a larger number of team members will be needed working on this aspect.

The way how this fluid prevention should be planned had been the topic of previous monographs [24;27].

4) Coordination and communication

Especially at the beginning of the intervention, there was no clear coordination of the different rescue actions, with difficulties sharing vital information among the different organizations on the ground. Teams in the field were not always aware about dialysis possibilities in Port-au-Prince. It is clear that better coordination and communication following a predefined intervention line are essential for efficacy.

Proactive incentives in between disaster periods by the RDRTF/ISN, distributing information on their activities, are desirable. Instruction on the spot should include regular contacts with primary care teams and non-nephrologic staff on the usefulness of hydration and bicarbonate administration and avoiding NSAIDs and potassium-containing fluids (Ringer's lactate) in patients with suspected crush syndrome. There is a need for a consistent approach to prevent and treat crush syndrome and AKI, including fluid resuscitation. A panel of experts is preparing crush recommendations under the aegis of ISN and European Renal Best Practice (ERBP), the guidance body of European Renal Association – Renal Dialysis and Transplantation Association (ERA-EDTA) [28]. Abbreviated versions and translations will be provided. On the occasion of the Haitian earthquake, preliminary versions were distributed, and, for their use in the DR, translated into Spanish by SLANH and DRTF/ASN.

5) Useless and bulky material

The shipment of useless material beyond request imposes practical problems which are often underestimated by donors. Shortly after the disaster, RDRTF received a donation of several thousands of liters of unrequested peritoneal dialysis (PD) fluid, which became known only when the whole shipment had been transported to Port-au-Prince. PD in disaster circumstances is considered less useful due to inadequate potassium removal, while there were no chronic PD patients in Haiti. In spite of the best of intentions, this donation obliged MSF to transport, unpack, sort, store and finally destroy tons of useless material. Hence, material donations should be limited to what is requested and should be coordinated with teams on the ground.

C. <u>THE CHILEAN DISASTER</u>

On Saturday February 27th, 2010, at 3.34 local time (6.34 GMT) the 8.8 Maule earthquake struck Chile with epicenter 115 km NNE of Concepción, the second city of the country (Fig 2). Reported mortality was 507. It was classified as the 7th most severe earthquake of all times and the second most severe of this century (after the 2004 Sumatra-Andaman tsunami quake). Here also, internal communication problems were substantial. Telephone contact with Concepción was possible only from Tuesday, March 2nd on. Communication from abroad with Santiago de Chile, on the other hand, was efficient, by connection possibilities with the local contact person for RDRTF/ISN who acted as a central link for nephrology and liaison with the Chilean Health Ministry.

Almost all fatalities were attributable to drowning due to an early tsunami and suffocation after collapse of adobe houses. Crush injury was rare. We are aware of only 2 dialyzed AKI patients who both recovered kidney function. The low mortality and prevalence of crush was largely attributable to the high standards of seismic building in Chile.

The main renal problem in Chile was related to the more than 2,500 chronic dialysis patients who were treated in the damaged area. Whereas in the region around Talca, problems could be solved by reallocation of patients and machines, the situation in Concepción was more challenging, due to more severe damage. Several dialysis units were originally out of order due to inadequate water distribution. Different scenarios for patient reallocation to outside the damaged area were developed. Ultimately, 100% of chronic patients had access to dialysis by Friday, March 5th. This necessitated reshuffling of patients and their schedules since by March 12th still only 60-70% of dialysis units were operational. Adaptation of hemodialysis schedules of chronic dialysis patients appeared useful also in previous disasters [19].

No international support was necessary.

D. CONCLUSIONS

No earthquake is comparable to another, and on site assessment by local or external experts is necessary to estimate nephrological needs. Preconceived intervention plans with clear indication of everybody's role are essential to overcome post-disaster chaos but are not always available [29]. The existing population on chronic dialysis should not be neglected in such plans and/or once an intervention is started.

The Haiti intervention made clear that it was possible to deploy dialysis rescue activities under extreme conditions. The Chile earthquake revealed that internal redistribution may solve many problems, if sufficient resources are available. In addition, the efficient organization of support and contact with the external world underscores the importance of local contact persons, who should be appointed in advance by the local nephrological societies [29].

In view of the apparent discrepancies between the Haitian and the Chilean intervention, with almost the entire focus on AKI in the first and on CKD in the latter, response at each disaster should be titrated to the likely expectations in this regard. Defining these needs is the task of local and international intervention coordinators, in consultation with the assessment team, as also happened during the two disasters described in this publication.

It also appears that it is essential that this type of Nephrology Task Force operates through a hands-on organization with good logistics such as MSF. In addition, the point-of-care device for assessment of

electrolyte and creatinine levels appeared to be a very useful tool and an essential piece of equipment for future similar disasters.

The number of dialyzed AKI patients in both disasters was low, but should be considered in the context of the local circumstances. None of the dialyzed patients in Haiti would have survived much longer without dialysis; however the impact of our intervention could have been higher had a number of elements beyond our control been more favorable. The low number of AKI in Chile demonstrates that careful implementation of appropriate architecture can play an important preventive role. In addition, both events were instructive for the future, e.g. about organizing screening with point-of-care devices, fluid prevention and affected dialysis units, and how to redistribute chronic dialysis patients.

For the first time, several victims with acute-on-chronic renal failure were recorded, in line with observations in non-disaster populations [30;31]. Although the finding is new in disasters, it is conceivable that similar cases were present already in previous events, although they were not registered. In future, this possibility should certainly be taken into account, in view of the apparent worse perspectives for recovery than with crush-AKI.

A comprehensive list of recommendations (to do's and don't do's) is given in table 4. Since fully documented recommendations for disaster-related crush are prepared by RDRTF-ISN and European Renal Best Practice (ERBP), the present advice should be considered as preliminary and prone to modification.

Acknowledgements: Interventions of this kind can only be accomplished with the help of many people. Coordination for MSF on the spot was done by R Crestani (Italy) and L Verhenne (Belgium). Coordination at the Brussels office of MSF was in hands of MC Ferir (Belgium). Secretarial coordination at the RDRTF/ISN offices was done by C Bergen (Belgium). The coordination of recruitment of nurses and technicians was in the hands of AM Cadart (France) and S Boule (Belgium). The Latin-American cell of RDRTF/ISN is coordinated by A Hurtado (Peru). The support by French volunteers from Martinique and Guadeloupe was highly appreciated, as well as the role of JM Dueymes as contact in Martinique. In the border area of the Dominican Republic, B Jaar (USA) and O Nuñez (Dominican Republic) played an essential role in the screening and triage of crush-related AKI. Several companies donated dialysis material or point-of-care machines.

The following RDRTF/ISN volunteers participated in this mission: the renal nurses D Borniche (France), S Claus (Belgium), V De Preester (Belgium), H Dunlop (UK), N Eyhartz (France), S Labbé (France), S Maddens (Belgium), C Martin (France), M Paris (France), C Peter (Switzerland), M Struelens (Belgium); the physicians M Augustin (France), R Bueno de Oliviera (Brazil), R Caluwé (Belgium), L Fernandes da Silva (Brazil), N Gibney (Canada), T Imam (USA), S Luyckx (Italy), MS Sever (Turkey), J Vanmassenhove (Belgium); and the technicians B Bonnet (France), H Correia (France), JP Garcia-Perez (France), P Stockman (Belgium), M Treffre (France).

In Haiti, surgeons from other medical teams assisted us with vascular access placement in chronic dialysis patients: R Riviello (USA) and R McCann (USA).

Next to the RDRTF/ISN action in Haiti itself, extensive exchanges with other international nephrology bodies such as the American Society of Nephrology (ASN), the Sociedad Latino Americana de Nephrología e Hipertensión (SLANH) and the Société de Néphrologie took place. We appreciated the many useful discussions with the respective coordinator of the ASN DRTF, D Portilla and the president of SLANH, R Correa-Rotter (Mexico). ASN DRTF organized regular telephone conferences to which both SLANH and RDRTF/ISN participated. Also the help by the colleagues from DR, and especially of the President of the Dominican Society of Nephrology, S Rodrigues (Santo Domingo), are highly appreciated. The coordination in Chile between the government and the nephrologic community was ascertained by R Wainstein, appointed by the Chilean Society of Nephrology as coordinator towards RDRTF/ISN.

More information on the activities of the RDRTF/ISN can be found on the ISN Gateway: http://www.isn-online.org/isn/index.html. Contact with RDRTF/ISN can be made by email at rdrtf@ugent.be. The Latin-American contact person of RDRTF/ISN can be reached at abdias.hurtado@upch.pe, the contacts for Asia at vjha@pginephro.org and d.harris@usyd.edu.au. The DRTF of ASN can be contacted at portilladidier@uams.edu.

Table 1: Major interventions of the Renal Disaster Relief Task Force*

Country	Date M/Y	Disaster	Intervention
Iran	3/97	Earthquake	Material support
Moldova	3/99	Breakdown dialysis stock	Material support
Macedonia	5/99	War	Evacuation chronic patients
Kosova	7/99	War	Material support
Turkey	8/99	Earthquake	Major intervention
Kosova	2/00	Post-war condition	Educational support
India	1/01	Earthquake	Assessment
Turkey	5/03	Earthquake	Material support
Algeria	5/03	Earthquake	Assessment
Iran	12/03	Earthquake	Major intervention
Louisiana/USA	8/05	Hurricane	Advisory role
Kashmir/Pakistan	10/05	Earthquake	Major intervention
Poland	1/06	Collapse sports hall	Advisory role
Indonesia	5/06	Earthquake	Assessment
Lebanon	7/06	War / breakdown stock	Material support
Peru	8/07	Earthquake	Assessment
Myanmar	5/08	Tornado	Advisory role
Wenchuan/China	5/08	Earthquake	Major intervention
L'Aquila/Italy	4/09	Earthquake	Advisory role
Indonesia	9/09	Earthquake	Assessment
Haiti	1/10	Earthquake	Major intervention
Chile	2/10	Earthquake	Advisory role
Turkey	3/10	Earthquake	Advisory role

*: modified and adapted from [8;10;11]; M:month; Y: year.

Table 2: Distribution of nationalities of volunteers

Country	Nurses	MDs	Technicians	Total
France	5	1	4	10
Belgium	4	2	1	7
Brazil	-	2	-	2
Switzerland	1	-	-	1
United Kingdom	1	-	-	1
Canada	-	1	-	1
Italy*	-	1	-	1
USA	-	1	-	1
Turkey	-	1	-	1
Total	11	9	5	25

*: Italian citizen, residing in Canada; MDs: medical doctors.

Table 3: Ratio of dialyzed/deaths (x 1,000)*

Location	Country	Year	Ratio
Spitak	Armenia	1988	9.0-15.4
Northern Iran	Iran	1990	3.9
Kobe	Japan	1995	24.6
Marmara	Turkey	1999	28.1
Chi-Chi	Taiwan	1999	13.3
Gujarat	India	2001	1.7
Boumerdes	Algeria	2003	6.6
Bam	Iran	2003	3.7
Kashmir	Pakistan	2005	2.4
Yogyakarta	Indonesia	2006	0.7
South of Lima	Peru	2007	9.6
Wenchuan	China	2008	1.9
L'Aquila	Italy	2009	29.3
Padang**	Indonesia	2009	0.0
Port-au-Prince***	Haiti	2010	0.2
Maule	Chile	2010	3.9

*: reported numbers may be an underestimation of reality; **: for the recent Padang earthquake, we are not aware of any dialyzed AKI-patient; ***: considering dialyzed crush patients in both Haiti and DR.

Table 4: Recommendations to optimize interventions in difficult disaster circumstances.*

- Avoid intervening:
    - Without advance planning and intervention flow charts
    - On your own without being embedded in a larger organization with experience in disaster intervention
    - Without logistic support
- Avoid:
    - Shipment of material that has not been requested
    - Logistic decisions resulting in bulky shipments
    - Enrolling volunteers without advance selection and screening
- Enroll not only physicians but also nurses and technicians
- Pay attention to:
    - Screening for AKI and fluid prevention (if possible)
    - Chronic dialysis patients, on dialysis before the disaster
- Initiate interventions with an assessment team evaluating local needs, if possible in consultation with representatives of the local nephrological community
- Try to arrive on the scene as soon as possible
- Look out for existing infrastructure and try to repair it if damaged
- Plan sufficient overlap on the spot among your consecutive intervention teams, so that essential information can be transferred among them
- Avoid too long duration of intervention per individual volunteer to avoid burn-out
- Consider:
    - Travel time as part of the intervention
    - Shipping light material with the hand luggage of new incoming volunteers

*: Of note, fully documented recommendations for disaster-related crush, including their rationale, are currently prepared by the RDRTF/ISN and ERBP. These recommendations are still under discussion among the different experts involved, and partially also depend on the upcoming Kidney Disease improving Global Outcomes (KDIGO) guidelines for AKI. What is recommended here is thus preliminary and might be presented differently in the final version of the recommendations.

CAPTIONS TO THE FIGURES

Fig. 1: A – Geographic situation of the island Hispaniola; Haiti in the West, the Dominican Republic (DR) in the East; the following cities are highlighted (underscore): in Haiti, Leogâne (the epicenter) and Port-au-Prince (the highly affected capital); in DR, Jimani and Barahona (border cities where the most important influx of victims from Haiti took place), and Santo Domingo, Santiago, San Pedro and San Juan (where most of the dialysis activities took place). B – city map of the metropolitan area of Port-au-Prince, with the damaged major buildings (legend: the coloured areas reflect severely damaged zones; pale: 10-40% of buildings damaged; dark: more than 40% damaged). Source, ref [14].

Fig 2: Geographic situation in Chile; the following cities are highlighted (underscore): Santiago de Chile (capital), Concepción and Talca (the most affected cities).

Fig 3: Google earth image of the campus of University Hospital (HUEH in Port-au-Prince). The destination of all buildings is indicated. The picture focuses on the dialysis unit in the middle with the MSF Land Cruiser standing outside (white vehicle). Some of the buildings were destroyed by the earthquake, e.g. the nursing school where more than 50 students were killed. The laboratory building was declared unsafe geologically. Patient care was in part delivered in tents (foreground).

Fig 4: Dialysis unit at University Hospital (HUEH) in Port-au-Prince. A and B: dialysis infrastructure as found by the RDRTF/ISN assessment team upon their arrival; blood lines and filters were left in place by dialysis patients running out of the unit at the occurrence of the earthquake; C to E: conditions of the water treatment system upon arrival; C: water softener with broken connectors; D: reverse osmosis system; E: existing 200 gallon water storage tank. F: new water storage system installed by RDRTF/ISN and MSF. Pictures are by the courtesy of P Stockman, volunteer technician in the assessment team.

Fig 5: Transition among the different volunteers and teams. Red: physicians; green: technicians; yellow: renal nurses. Left margin: nationalities. Although the intervention was planned to end on February 27th, dialysis machines that had been ordered since several weeks to be dispatched from nearby Martinique, were first withheld in Martinique and then at customs in Haiti, so that an extra team consisting of 1 physician and 1 dialysis technician had to be enrolled. As a consequence, the mission ended only on March 14th, exactly two months after the departure of the first team. The length of intervention for each participant as presented here includes travel time which totaled at least 4 days for most.

Fig 6: Local conditions in Port-au-Prince in the first days after the disaster. A and B: wounded lying outside in the open air; C: crush wound; D and E: in-hospital conditions; F: newly erected tent for medical care. Pictures are by the courtesy of S Maddens, volunteer nurse in the assessment team.